of a field laboratory under the program of FSICM (Field School of Integrated Crop Management) of Agricultural Department at Magelang Regency.

Field Observation

The land physiographic, land use, water resource, crop pattern and farming system were observed, including the rice variety and crop input for every season.

Soil and Rice Leaf Sampling

The area of field laboratory was about1 ha, consisted of 13 rice patches. Soil sample was taken from each patch and every two weeks to give time variability description at the same spot. Totally there were 39 soil samples, in all had been analyzed its physical and chemical properties, i.e.: soil texture and consistency, C-organic content, Total N, N-NO3. Rice leaf sample was taken at the phase of maximum vegetative growth using Leaf Color Chart (LCC) to determine the nitrogen status of rice at each patch.

Water Sampling

To determine the water quality, water sample was taken in three points at a continuous water flow from highest to lowest observed rice field, i.e. at the intake, at the center, and at the output. Each point was sampled three times within 3 weeks using electro chemical and electro physical method with Grocheckmeter device. The parameters to determine were pH, temperature, Electric Conductivity and Total Dissolved Solid. Debit measurement is by using electric method with Currentmeter device to determine the flow velocity at waterway.

Soil Variability Mapping

The borders of village and rice patches were mapped using GPS receiver, and analyzed with ArcView software. Information of soil properties for each sampling time was overlaid on every patch in digital map of research area.

RESULTS AND DISCUSSION

Soil variability

Salaman has Inceptisol soil type with grey 1 3/10 Y color, very dark greenish gray, and 5.7 of pH. The variability of soil texture, nitrate content (NO3), C-organic content, Total N and C/N ratio were drawn in digital maps that are shown in Figure 1 to 5. They were varied among patches and time.

The variability of nitrate (NO3) content of soil at different field and time are shown in Figure 1b. The nitrate content in all patches was very low due to the low value of organic matter and total N content. The NO3 was possibly derived from chemical nitrogen input. However, excessive chemical fertilizer nitrogen would be inefficient. They were dominantly in the form of nitrate, because negative nitrate was not bounded by negative soil minerals, so it will be dissolved into water.

From these conditions, it appears that besides improving the crop input by applying organic fertilizer, it is also necessary to overcome the possibility of N pollution from chemical fertilizers. So far, this nitrate contamination to water bodies had not been occurred, however it is important to calculate the exact amount of N requirement for each location and time of application. The method used by farmer in applying chemical nitrogen fertilizer was by spreading onto the soil without penetration. This would cause the nitrogen to be easily changed into nitrate form due to oxidation. The method of N fertilizer application should be improved, especially in the rainy season.

Kalirejo Village, Salaman District, Magelang Regency, Central Java.

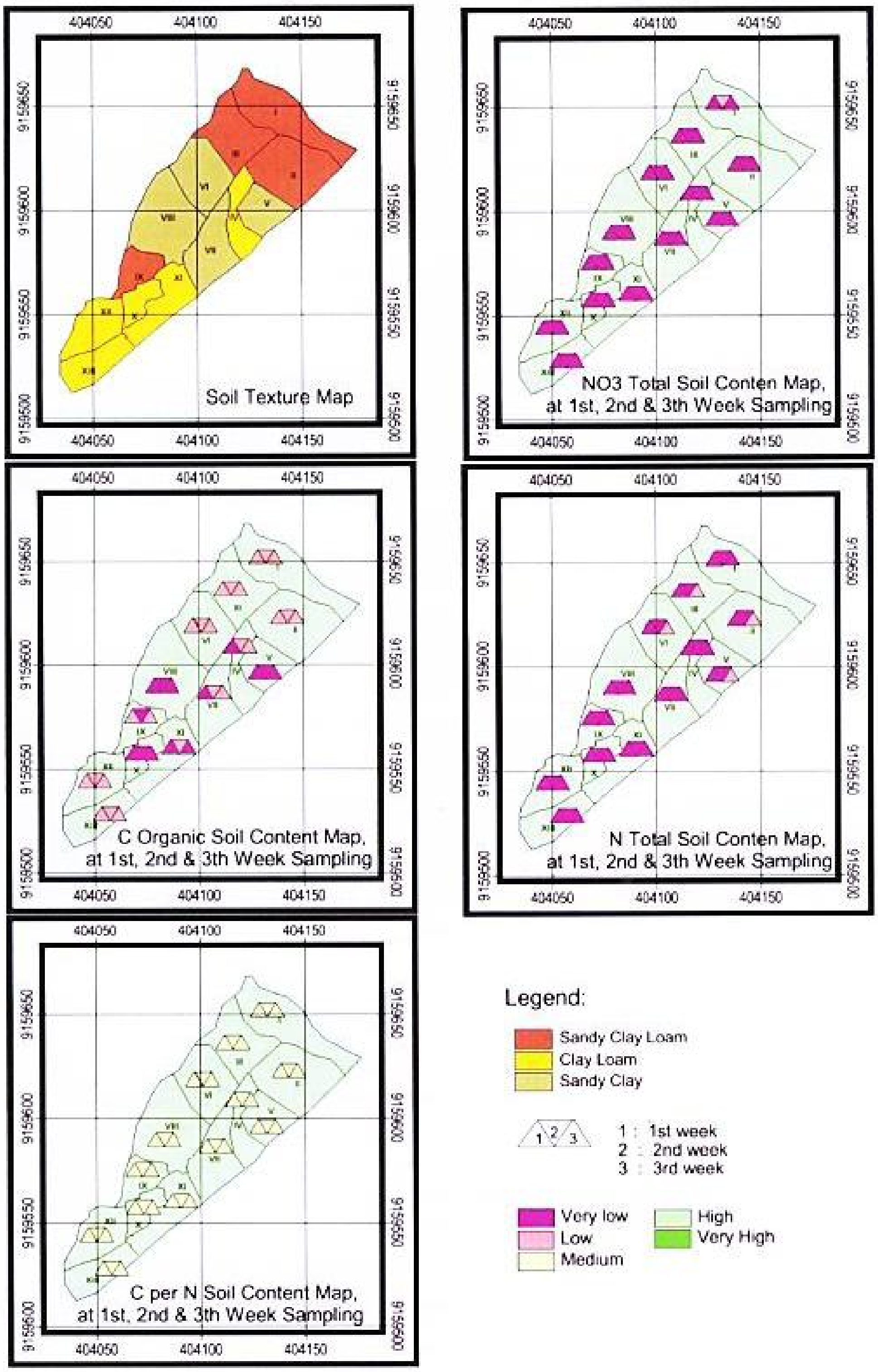

Figure 1. Map of soil variability at 1st, 2nd, 3rd week of measurement
a. Soil Texture; b. Soil Consistency; c. C Organic content; d. N Total; e. C/N ratio

Water properties

The altitude of Salaman is about 425 m above sea level with hilly topography, the series of Menoreh hills. Terrace slopes vary between 5 to 8% with narrow contours and face to the west. With medium surface drainage, this area is free from flood.

Water supply (irrigation) for agricultural and plantation area are from the rain fed and the stream that goes down to Progo River, so this area belongs to Progo watershed. Salaman is a water catchment area that also supplies water to Borobudur through Tangsi irrigation canal. The volume of water requirement for irrigation through Tangsi canal was about 78 million m3/year cover 1448 ha rice fields surround Borobudur (Anonymous, 2009).

Besides the volume, the quality of water is also important to be considered in consuming the water. The water quality and discharge at the research rice fields is shown in Table 1.

Table 1.Water Quality and Discharge at Salaman District in research rice fields

Measurement time	pH	Temp (^{0}C)	EC (mS/cm)	TDS (ppm)	discharge (Q) ml/s
Week I	7.533	30.0	0.226	171	5563.333
Week II	7.566	30.0	0.256	175	4297.778
Week III	7.533	27.4	0.256	183	868.571

Source: Kristanto, 2010

The pH indicated that water quality was normal, and the temperature was suitable for rice growth. The low electric conductivity showed that the soil had plenty organic matter. The Total Dissolved Solid was still under the threshold of permitted value, less than 1000 ppm (PP No.82, 2001).

The water discharge was decreased from 1st week to 3rd week of measurement; because the rainfall had been reduced. However, in this case the water amount had not been precisely calculated daily with water balance formula that depends on the crop water requirement of every growth stage. The farmers still used water excessively more than its requirement otherwise they felt unsatisfied if their crop could not get abundance water.

Managing Soil and Water Variability

Implementation of precision agriculture needs an appropriate integrated system that combines the hard technology and soft systems as shown in Figure 2. Digital soil fertility mapping is used for describing the variation of soil condition. Soil sampling should be paid attention seriously in order to obtain an adequate variability analysis and efficient sampling method. Once the digital map of soil fertility has been created, the result of soil analysis may be implemented using variable rate application (VRA) method. VRA needs correct positioning in the field; correct information at the location; and timely operations at the site concerned.

Increased efficiency in management systems is a key aspect of precision agriculture, especially in smallholder systems where funds to buy large amounts of external inputs are often in short supply. The approach carries many clear messages, including not to waste fertilizer on soils that are constrained by other factors (Stoorvogel, 2006).

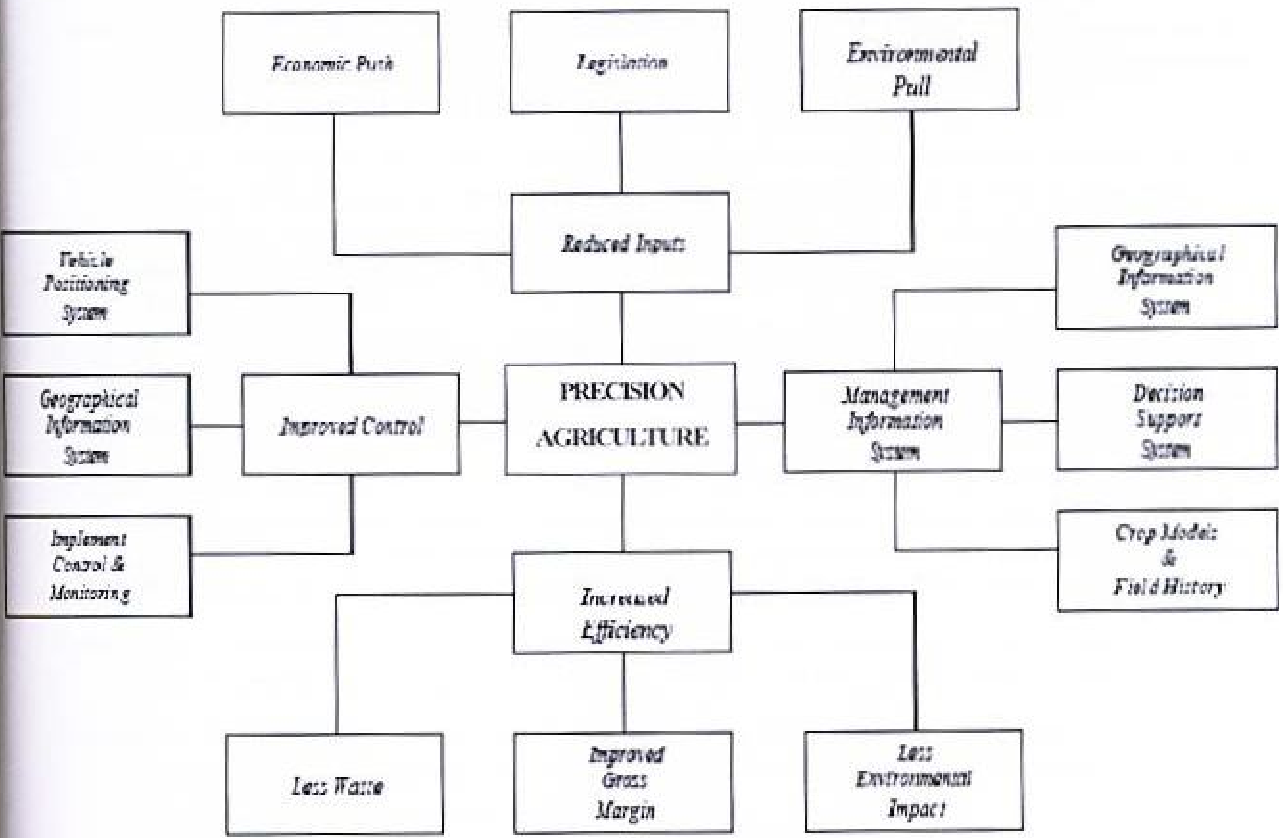

Figure 2. Diagram of Precision Agriculture Technology System Approach

Water efficiency can be approached by using water balance software that allows the scheduling of irrigation for different management conditions and calculation of water supply for varying cropping patterns. The excessive irrigation water can be allocated to other purposes.

The increasing activities in agro-tourism sector would affect to the increasing amount of solid and fluid waste, not only to the soil but also to the water body. It is threaten to the quality of water for human, animal and plant consumptions. Due to the complexity factors, PA practices should be implemented within fields, and the protection must be based on watershed system, in this case is Progo Watershed that covers some part in Central Java Province and the other in Yogyakarta Province.

ACKNOWLEDGEMENT

This research was funded by Directorate General of Higher Education, Department of National Education, Republic of Indonesia (Education for Sustainable Development Program, 2010) and supported by Agency of Food Crops Plantation and Forestry, Agricultural Department at Magelang Regency. The authors would like to express gratitude to Prof. Sakae Shibusawa, TUAT Japan, for supervising this research.

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